APPENDIX A:
Hybrid System Model and Economic Summary Tables

This appendix contains the hybrid system model and economic summary tables used to develop the economic conclusions reached in this report.

SAN CLEMENTE ISLAND HYBRID SYSTEM MODEL

Maximum number of wind turbines: 1

		diesel only						wind hybrid										98.4 ft
Date	Time (hr)	Demand (kW)	Diesel Rating (kW)	Percent of Rating Used	Litres of Diesel Consumed	starts counter	Diesel run time (hours)	Adjusted Wind Speed (m/s)	Single Turbine Wind Power (kW)	Maximum Allowed Wind Demand (kW)	Number of Turbines	Net Demand (kW)	Diesel Rating (kW)	Percent of Rating Used	Litres of Diesel Consumed	starts counter	Diesel run time (hours)	litres saved	Original Wind Speed 6.1 m/s
Average		869.7	1531.7	58%	306.9			6.1	53.1	669.7	0.8	816.5	1448.9	0.5	293.2			13.7844	6.119481
Standard Deviation		114.0	236.3	8%	37.9			3.1	60.9	114.0	0.4	107.0	250.0	0.1	35.5			15.80659	3.10947
Maximum		1519.1	1700.0	89%	484.3			21.6	229.4	1319.1	1.0	1289.8	1700.0	0.8	424.9			59.48818	21.62711
Minimum		514.2	1200.0	32%	197.1			0.3	0.0	314.2	0.0	489.8	1200.0	0.3	197.1			0	0.300872
Total		7618476			2688873	196	14572		465547	5866476		7152929			2568122	220	13121	120751	

465547 Wind Energy Used
465547 Wind Energy Available
0 Wind Energy Curtailed

Maximum number of wind turbines: 2

		diesel only						wind hybrid										98.4 ft
Date	Time (hr)	Demand (kW)	Diesel Rating (kW)	Percent of Rating Used	Litres of Diesel Consumed	starts counter	Diesel run time (hours)	Adjusted Wind Speed (m/s)	Single Turbine Wind Power (kW)	Maximum Allowed Wind Demand (kW)	Number of Turbines	Net Demand (kW)	Diesel Rating (kW)	Percent of Rating Used	Litres of Diesel Consumed	starts counter	Diesel run time (hours)	litres saved	Original Wind Speed 6.1 m/s
Average		869.7	1531.7	58%	306.9			6.1	53.1	669.7	1.7	763.4	1393.1	0.5	279.4			27.5688	6.119481
Standard Deviation		114.0	236.3	8%	37.9			3.1	60.9	114.0	0.7	131.6	243.6	0.1	39.8			31.61318	3.10947
Maximum		1519.1	1700.0	89%	484.3			21.6	229.4	1319.1	2.0	1277.8	1700.0	0.8	421.7			119	21.62711
Minimum		514.2	1200.0	32%	197.1			0.3	0.0	314.2	0.0	261.1	750.0	0.2	154.8			0	0.300872
Total		7618476			2688873	196	14572		465547	5866476		6687381			2447371	236	12144	241503	

931095 Wind Energy Used
931095 Wind Energy Available
0 Wind Energy Curtailed

Maximum number of wind turbines: 3

		diesel only						wind hybrid										98.4 ft
Date	Time (hr)	Demand (kW)	Diesel Rating (kW)	Percent of Rating Used	Litres of Diesel Consumed	starts counter	Diesel run time (hours)	Adjusted Wind Speed (m/s)	Single Turbine Wind Power (kW)	Maximum Allowed Wind Demand (kW)	Number of Turbines	Net Demand (kW)	Diesel Rating (kW)	Percent of Rating Used	Litres of Diesel Consumed	starts counter	Diesel run time (hours)	litres saved	Original Wind Speed 6.1 m/s
Average		869.7	1531.7	58%	306.9			6.1	53.1	669.7	2.5	711.4	1355.1	0.5	265.9			41	6.119481
Standard Deviation		114.0	236.3	8%	37.9			3.1	60.9	114.0	1.1	172.0	247.3	0.1	48.3			46.75209	3.10947
Maximum		1519.1	1700.0	89%	484.3			21.6	229.4	1319.1	3.0	1277.8	1700.0	0.8	421.7			178.4645	21.62711
Minimum		514.2	1200.0	32%	197.1			0.3	0.0	314.2	0.0	201.0	750.0	0.1	116.1			0	0.300872
Total		7618476			2688873	196	14572		465547	5866476		6232205			2329309	282	11618	359564	

1386271 Wind Energy Used
1396642 Wind Energy Available
10371 Wind Energy Curtailed

Maximum number of wind turbines: 4

		diesel only						wind hybrid										98.4 ft
Date	Time (hr)	Demand (kW)	Diesel Rating (kW)	Percent of Rating Used	Litres of Diesel Consumed	starts counter	Diesel run time (hours)	Adjusted Wind Speed (m/s)	Single Turbine Wind Power (kW)	Maximum Allowed Wind Demand (kW)	Number of Turbines	Net Demand (kW)	Diesel Rating (kW)	Percent of Rating Used	Litres of Diesel Consumed	starts counter	Diesel run time (hours)	litres saved	Original Wind Speed 6.1 m/s
Average		869.7	1531.7	58%	306.9			6.1	53.1	669.7	3.3	668.5	1328.3	0.4	254.8			52	6.119481
Standard Deviation		114.0	236.3	8%	37.9			3.1	60.9	114.0	1.4	201.7	259.2	0.1	55.0			57.26681	3.10947
Maximum		1519.1	1700.0	89%	484.3			21.6	229.4	1319.1	4.0	1277.8	1700.0	0.8	421.7			237.9527	21.62711
Minimum		514.2	1200.0	32%	197.1			0.3	0.0	314.2	0.0	200.2	750.0	0.1	116.1			0	0.300872
Total		7618476			2688873	196	14572		465547	5866476		5856374			2231828	312	11367	457045	

1782102 Wind Energy Used
1882189 Wind Energy Available
100087 Wind Energy Curtailed

ECONOMIC ANALYSIS **Site:** **San Clemente Island, CA, 6.1 m/s avg**
Turbine: **225 kW, Commercial**
Quantity: **1**

Input Values

System load (kWh/y)	SL	7,618,476
Diesel energy (kWh/y)		7,152,929
Wind energy (kWh/y)		465,547
Diesel fuel usage, no wind (l/yr)	FL	2,688,873
Diesel fuel usage, with wind (l/yr)	FL	2,568,122
Diesel fuel cost ($/l)	FC	0.264
Diesel ops cost, variable ($/kWh)	OV	0.154
Diesel ops cost, fixed ($/y)	OF	1,173,245
Wind ICC ($)	WC	685,510
Wind O&M cost ($/kWh)	WO	0.01
System life, (yrs)	L	20
General inflation	i	2.0%
Fuel inflation	e	2.0%
Discount rate	d	6.9%
Interest	b	10.0%
Term of loan, (yrs)	N	10

Economic Factors

	a variable	n variable	Y(a,n)
Present worth factor of fuel costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Present worth factor of O&M costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Present worth factor of interest payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616

	a variable	n variable	X(a,n)
Capital recovery factor for system income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Capital recovery factor for interest payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539

Calculated Values for Both Systems

		Diesel Only	Hybrid System Diesel Part	Hybrid System Wind Part	Hybrid System Total
Capital cost	C = ICC+BOS	0	0	685,510	685,510
Initial payment on system	Ad	0	0	685,510	685,510
Loan	Al = C - Ad	0	0	0	0
Annual payment	Ap = Al * CRFP	0	0	0	0
NPV of annual payment	Apnpv = Ap*PWFP	0	0	0	0
Fuel cost per annum	Af = FL * FC	709,863	677,984	0	677,984
NPV of fuel costs	Afnpv = Af * PWFF	8,995,402	8,591,439	0	8,591,439
Overhaul cost per annum	Ao	0	0	1,000	1,000
NPV of overhaul costs	Aonpv = Ao * PWFO	0	0	12,672	12,672
O&M costs per annum	Am	2,346,490	2,274,796	4,655	2,279,451
NPV of O&M costs	Amnpv = Am*PWFO	29,734,802	28,826,290	58,994	28,885,284
Total annual costs	At = Ap+Af+Ao+Am	3,056,353	2,952,780	5,655	2,958,436
Total system NPV, TNPV	= Ad+sum(NPVs)	38,730,204	37,417,728	757,176	38,174,905
Annual savings	Sv = dsl At - hbd At				97,917
Levelized cost of energy, COE	= TNPV*CRFI/SL	0.476	0.490	0.152	0.469
Payback period, years					7.00
Internal rate of return, IRR, (x)	[(1+x)^L-1]/[x*(1+x)^L] - P =		0.000		13.1%

(NPV = net present value; ICC = initial capitol cost; BOS = balance of station = 26% ICC; O&M = operations and maintenance)

ECONOMIC ANALYSIS **Site:** **San Clemente Island, CA, 5.0 m/s avg**
Turbine: **225 kW, Commercial**
Quantity: **2**

Input Values

System load (kWh/y)	SL	7,618,476
Diesel energy (kWh/y)		7,042,272
Wind energy (kWh/y)		576,204
Diesel fuel usage, no wind (l/yr)	FL	2,688,873
Diesel fuel usage, with wind (l/yr)	FL	2,539,421
Diesel fuel cost ($/l)	FC	0.264
Diesel ops cost, variable ($/kWh)	OV	0.154
Diesel ops cost, fixed ($/y)	OF	1,173,245
Wind ICC ($)	WC	635,510
Wind O&M cost ($/kWh)	WO	0.01
System life, (yrs)	L	20
General inflation	i	2.0%
Fuel inflation	e	2.0%
Discount rate	d	6.9%
Interest	b	10.0%
Term of loan, (yrs)	N	10

Economic Factors

	a variable	n variable	Y(a,n)
Present worth factor of fuel costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Present worth factor of O&M costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Present worth factor of interest payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616

	a variable	n variable	X(a,n)
Capital recovery factor for system income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Capital recovery factor for interest payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539

Calculated Values for Both Systems

		Diesel Only	Hybrid System Diesel Part	Hybrid System Wind Part	Hybrid System Total
Capital cost	C = ICC+BOS	0	0	1,271,020	1,271,020
Initial payment on system	Ad	0	0	1,271,020	1,271,020
Loan	Al = C - Ad	0	0	0	0
Annual payment	Ap = Al * CRFP	0	0	0	0
NPV of annual payment	Apnpv = Ap*PWFP	0	0	0	0
Fuel cost per annum	Af = FL * FC	709,863	670,407	0	670,407
NPV of fuel costs	Afnpv = Af * PWFF	8,995,402	8,495,420	0	8,495,420
Overhaul cost per annum	Ao	0	0	2,000	2,000
NPV of overhaul costs	Aonpv = Ao * PWFO	0	0	25,344	25,344
O&M costs per annum	Am	2,346,490	2,257,755	5,762	2,263,517
NPV of O&M costs	Amnpv = Am*PWFO	29,734,802	28,610,344	73,017	28,683,361
Total annual costs	At = Ap+Af+Ao+Am	3,056,353	2,928,162	7,762	2,935,924
Total system NPV, TNPV	= Ad+sum(NPVs)	38,730,204	37,105,764	1,369,381	38,475,145
Annual savings	Sv = dsl At - hbd At				120,429
Levelized cost of energy, COE	= TNPV*CRFI/SL	0.476	0.493	0.223	0.473
Payback period, years					10.55
Internal rate of return, IRR, (x)	[(1+x)^L-1]/[x*(1+x)^L] - P =		0.000		7.0%

(NPV = net present value; ICC = initial capitol cost; BOS = balance of station = 26% ICC; O&M = operations and maintenance)

ECONOMIC ANALYSIS **Site:** **San Clemente Island, CA, 6.1 m/s avg**
Turbine: **225 kW, Commercial**
Quantity: **2**

Input Values

System load (kWh/y)	SL	7,618,476
Diesel energy (kWh/y)		6,687,381
Wind energy (kWh/y)		931,095
Diesel fuel usage, no wind (l/yr)	FL	2,688,873
Diesel fuel usage, with wind (l/yr)	FL	2,447,371
Diesel fuel cost ($/l)	FC	0.264
Diesel ops cost, variable ($/kWh)	OV	0.154
Diesel ops cost, fixed ($/y)	OF	1,173,245
Wind ICC ($)	WC	635,510
Wind O&M cost ($/kWh)	WO	0.01
System life, (yrs)	L	20
General inflation	i	2.0%
Fuel inflation	e	2.0%
Discount rate	d	6.9%
Interest	b	10.0%
Term of loan, (yrs)	N	10

Economic Factors

	a variable	n variable	Y(a,n)
Present worth factor of fuel costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Present worth factor of O&M costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Present worth factor of interest payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616

	a variable	n variable	X(a,n)
Capital recovery factor for system income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Capital recovery factor for interest payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539

Calculated Values for Both Systems

		Diesel Only	Hybrid System Diesel Part	Hybrid System Wind Part	Hybrid System Total
Capital cost	C = ICC+BOS	0	0	1,271,020	1,271,020
Initial payment on system	Ad	0	0	1,271,020	1,271,020
Loan	Al = C - Ad	0	0	0	0
Annual payment	Ap = Al * CRFP	0	0	0	0
NPV of annual payment	Apnpv = Ap*PWFP	0	0	0	0
Fuel cost per annum	Af = FL * FC	709,863	646,106	0	646,106
NPV of fuel costs	Afnpv = Af * PWFF	8,995,402	8,187,475	0	8,187,475
Overhaul cost per annum	Ao	0	0	2,000	2,000
NPV of overhaul costs	Aonpv = Ao * PWFO	0	0	25,344	25,344
O&M costs per annum	Am	2,346,490	2,203,102	9,311	2,212,413
NPV of O&M costs	Amnpv = Am*PWFO	29,734,802	27,917,777	117,989	28,035,766
Total annual costs	At = Ap+Af+Ao+Am	3,056,353	2,849,208	11,311	2,860,519
Total system NPV, TNPV	= Ad+sum(NPVs)	38,730,204	36,105,252	1,414,353	37,519,605
Annual savings	Sv = dsl At - hbd At				195,834
Levelized cost of energy, COE	= TNPV*CRFI/SL	0.476	0.506	0.142	0.461
Payback period, years					6.49
Internal rate of return, IRR, (x)	[(1+x)^L-1]/[x*(1+x)^L] - P =		0.000		14.4%

(NPV = net present value; ICC = initial capitol cost; BOS = balance of station = 26% ICC; O&M = operations and maintenance)

ECONOMIC ANALYSIS **Site:** **San Clemente Island, CA, 7.2 m/s avg**
Turbine: **225 kW, Commercial**
Quantity: **2**

Input Values

System load (kWh/y)	SL	7,618,476
Diesel energy (kWh/y)		6,323,127
Wind energy (kWh/y)		1,295,349
Diesel fuel usage, no wind (l/yr)	FL	2,688,873
Diesel fuel usage, with wind (l/yr)	FL	2,352,892
Diesel fuel cost ($/l)	FC	0.264
Diesel ops cost, variable ($/kWh)	OV	0.154
Diesel ops cost, fixed ($/y)	OF	1,173,245
Wind ICC ($)	WC	635,510
Wind O&M cost ($/kWh)	WO	0.01
System life, (yrs)	L	20
General inflation	i	2.0%
Fuel inflation	e	2.0%
Discount rate	d	6.9%
Interest	b	10.0%
Term of loan, (yrs)	N	10

Economic Factors

	a variable	n variable	Y(a,n)
Present worth factor of fuel costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Present worth factor of O&M costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Present worth factor of interest payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616

	a variable	n variable	X(a,n)
Capital recovery factor for system income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Capital recovery factor for interest payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539

Calculated Values for Both Systems

		Diesel Only	Hybrid System Diesel Part	Hybrid System Wind Part	Hybrid System Total
Capital cost	C = ICC+BOS	0	0	1,271,020	1,271,020
Initial payment on system	Ad	0	0	1,271,020	1,271,020
Loan	Al = C - Ad	0	0	0	0
Annual payment	Ap = Al * CRFP	0	0	0	0
NPV of annual payment	Apnpv = Ap*PWFP	0	0	0	0
Fuel cost per annum	Af = FL * FC	709,863	621,164	0	621,164
NPV of fuel costs	Afnpv = Af * PWFF	8,995,402	7,871,405	0	7,871,405
Overhaul cost per annum	Ao	0	0	2,000	2,000
NPV of overhaul costs	Aonpv = Ao * PWFO	0	0	25,344	25,344
O&M costs per annum	Am	2,346,490	2,147,007	12,953	2,159,960
NPV of O&M costs	Amnpv = Am*PWFO	29,734,802	27,206,938	164,147	27,371,085
Total annual costs	At = Ap+Af+Ao+Am	3,056,353	2,768,170	14,953	2,783,124
Total system NPV, TNPV	= Ad+sum(NPVs)	38,730,204	35,078,343	1,460,511	36,538,854
Annual savings	Sv = dsl At - hbd At				273,229
Levelized cost of energy, COE	= TNPV*CRFI/SL	0.476	0.520	0.106	0.449
Payback period, years					4.65
Internal rate of return, IRR, (x)	[(1+x)^L-1]/[x*(1+x)^L] - P =		0.000		21.0%

(NPV = net present value; ICC = initial capitol cost; BOS = balance of station = 26% ICC; O&M = operations and maintenance)

ECONOMIC ANALYSIS **Site:** **San Clemente Island, CA, 6.1 m/s avg**
Turbine: **225 kW, Commercial**
Quantity: **3**

Input Values

System load (kWh/y)	SL	7,618,476
Diesel energy (kWh/y)		6,232,205
Wind energy (kWh/y)		1,386,271
Diesel fuel usage, no wind (l/yr)	FL	2,688,873
Diesel fuel usage, with wind (l/yr)	FL	2,329,309
Diesel fuel cost ($/l)	FC	0.264
Diesel ops cost, variable ($/kWh)	OV	0.154
Diesel ops cost, fixed ($/y)	OF	1,173,245
Wind ICC ($)	WC	610,510
Wind O&M cost ($/kWh)	WO	0.01
System life, (yrs)	L	20
General inflation	i	2.0%
Fuel inflation	e	2.0%
Discount rate	d	6.9%
Interest	b	10.0%
Term of loan, (yrs)	N	10

Economic Factors

	a variable	n variable	Y(a,n)
Present worth factor of fuel costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Present worth factor of O&M costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Present worth factor of interest payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616

	a variable	n variable	X(a,n)
Capital recovery factor for system income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Capital recovery factor for interest payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539

Calculated Values for Both Systems

		Diesel Only	Hybrid System Diesel Part	Hybrid System Wind Part	Hybrid System Total
Capital cost	C = ICC+BOS	0	0	1,831,530	1,831,530
Initial payment on system	Ad	0	0	1,831,530	1,831,530
Loan	Al = C - Ad	0	0	0	0
Annual payment	Ap = Al * CRFP	0	0	0	0
NPV of annual payment	Apnpv = Ap*PWFP	0	0	0	0
Fuel cost per annum	Af = FL * FC	709,863	614,938	0	614,938
NPV of fuel costs	Afnpv = Af * PWFF	8,995,402	7,792,510	0	7,792,510
Overhaul cost per annum	Ao	0	0	3,000	3,000
NPV of overhaul costs	Aonpv = Ao * PWFO	0	0	38,016	38,016
O&M costs per annum	Am	2,346,490	2,133,005	13,863	2,146,867
NPV of O&M costs	Amnpv = Am*PWFO	29,734,802	27,029,503	175,669	27,205,172
Total annual costs	At = Ap+Af+Ao+Am	3,056,353	2,747,942	16,863	2,764,805
Total system NPV, TNPV	= Ad+sum(NPVs)	38,730,204	34,822,014	2,045,215	36,867,229
Annual savings	Sv = dsl At - hbd At				291,548
Levelized cost of energy, COE	= TNPV*CRFI/SL	0.476	0.523	0.138	0.453
Payback period, years					6.28
Internal rate of return, IRR, (x)	[(1+x)^L-1]/[x*(1+x)^L] - P =		0.000		14.9%

(NPV = net present value; ICC = initial capitol cost; BOS = balance of station = 26% ICC; O&M = operations and maintenance)

ECONOMIC ANALYSIS **Site:** **San Clemente Island, CA, 6.1 m/s avg**
Turbine: **225 kW, Commercial**
Quantity: **4**

Input Values

System load (kWh/y)	SL	7,618,476
Diesel energy (kWh/y)		5,856,374
Wind energy (kWh/y)		1,762,102
Diesel fuel usage, no wind (l/yr)	FL	2,688,873
Diesel fuel usage, with wind (l/yr)	FL	2,231,828
Diesel fuel cost ($/l)	FC	0.264
Diesel ops cost, variable ($/kWh)	OV	0.154
Diesel ops cost, fixed ($/y)	OF	1,173,245
Wind ICC ($)	WC	585,510
Wind O&M cost ($/kWh)	WO	0.01
System life, (yrs)	L	20
General inflation	i	2.0%
Fuel inflation	e	2.0%
Discount rate	d	6.9%
Interest	b	10.0%
Term of loan, (yrs)	N	10

Economic Factors

	a variable	n variable	Y(a,n)
Present worth factor of fuel costs, PWFF, a=(1+e)/(1+d)	0.95416	20	12.67203
Present worth factor of O&M costs, PWFO, a=(1+i)/(1+d)	0.95416	20	12.67203
Present worth factor of interest payments, PWFP, a=1/(1+b)	0.93545	10	7.05616

	a variable	n variable	X(a,n)
Capital recovery factor for system income, CRFI, a=1/(1+d)	0.93545	20	0.09366
Capital recovery factor for interest payments, CRFP, a=1/(1+b)	0.90909	10	0.16275

Calculated Values for Both Systems

		Diesel Only	Hybrid System Diesel Part	Hybrid System Wind Part	Hybrid System Total
Capital cost	C = ICC+BOS	0	0	2,342,040	2,342,040
Initial payment on system	Ad	0	0	2,342,040	2,342,040
Loan	Al = C - Ad	0	0	0	0
Annual payment	Ap = Al * CRFP	0	0	0	0
NPV of annual payment	Apnpv = Ap*PWFP	0	0	0	0
Fuel cost per annum	Af = FL * FC	709,863	589,203	0	589,203
NPV of fuel costs	Afnpv = Af * PWFF	8,995,402	7,466,395	0	7,466,395
Overhaul cost per annum	Ao	0	0	4,000	4,000
NPV of overhaul costs	Aonpv = Ao * PWFO	0	0	50,688	50,688
O&M costs per annum	Am	2,346,490	2,075,127	17,621	2,092,748
NPV of O&M costs	Amnpv = Am*PWFO	29,734,802	26,296,072	223,294	26,519,366
Total annual costs	At = Ap+Af+Ao+Am	3,056,353	2,664,329	21,621	2,685,950
Total system NPV, TNPV	= Ad+sum(NPVs)	38,730,204	33,762,467	2,616,022	36,378,490
Annual savings	Sv = dsl At - hbd At				370,403
Levelized cost of energy, COE	= TNPV*CRFI/SL	0.476	0.540	0.139	0.447
Payback period, years	P = C / Sv				6.32
Internal rate of return, IRR, (x)	[(1+x)^L-1]/[x*(1+x)^L] - P =		0.000		14.8%

(NPV = net present value; ICC = initial capitol cost; BOS = balance of station = 26% ICC; O&M = operations and maintenance)

ECONOMIC ANALYSIS **Site:** **Fictitious Mainland Site, Non-Naval, 6.1 m/s avg**
Turbine: **225 kW, Commercial**
Quantity: **2**

Input Values

System load (kWh/y)	SL	7,618,476
Diesel energy (kWh/y)		6,687,381
Wind energy (kWh/y)		931,095
Diesel fuel usage, no wind (l/yr)	FL	2,688,873
Diesel fuel usage, with wind (l/yr)	FL	2,447,371
Diesel fuel cost ($/l)	FC	0.264
Diesel ops cost, variable ($/kWh)	OV	0.154
Diesel ops cost, fixed ($/y)	OF	1,173,245
Wind ICC ($)	WC	354,600
Wind O&M cost ($/kWh)	WO	0.01
System life, (yrs)	L	20
General inflation	i	2.0%
Fuel inflation	e	2.0%
Discount rate	d	6.9%
Interest	b	10.0%
Term of loan, (yrs)	N	10

Economic Factors

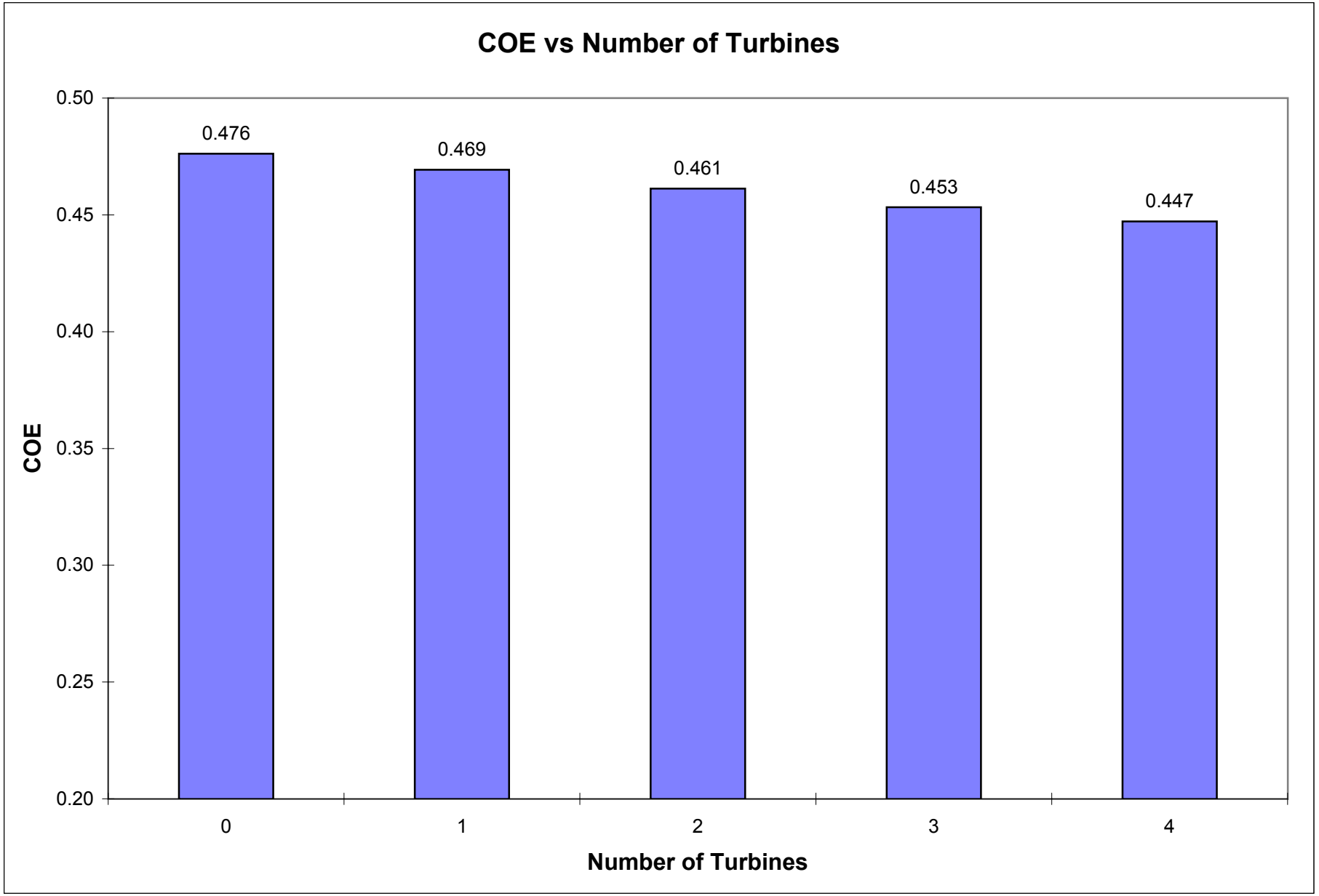
	a variable	n variable	Y(a,n)
Present worth factor of fuel costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Present worth factor of O&M costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Present worth factor of interest payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616

	a variable	n variable	X(a,n)
Capital recovery factor for system income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Capital recovery factor for interest payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539

Calculated Values for Both Systems

		Diesel Only	Hybrid System Diesel Part	Hybrid System Wind Part	Hybrid System Total
Capital cost	C = ICC+BOS	0	0	709,200	709,200
Initial payment on system	Ad	0	0	709,200	709,200
Loan	Al = C - Ad	0	0	0	0
Annual payment	Ap = Al * CRFP	0	0	0	0
NPV of annual payment	Apnpv = Ap*PWFP	0	0	0	0
Fuel cost per annum	Af = FL * FC	709,863	646,106	0	646,106
NPV of fuel costs	Afnpv = Af * PWFF	8,995,402	8,187,475	0	8,187,475
Overhaul cost per annum	Ao	0	0	2,000	2,000
NPV of overhaul costs	Aonpv = Ao * PWFO	0	0	25,344	25,344
O&M costs per annum	Am	2,346,490	2,203,102	9,311	2,212,413
NPV of O&M costs	Amnpv = Am*PWFO	29,734,802	27,917,777	117,989	28,035,766
Total annual costs	At = Ap+Af+Ao+Am	3,056,353	2,849,208	11,311	2,860,519
Total system NPV, TNPV	= Ad+sum(NPVs)	38,730,204	36,105,252	852,533	36,957,785
Annual savings	Sv = dsl At - hbd At				195,834
Levelized cost of energy, COE	= TNPV*CRFI/SL	0.476	0.506	0.086	0.454
Payback period, years					3.62
Internal rate of return, IRR, (x)	[(1+x)^L-1]/[x*(1+x)^L] - P =		0.000		27.4%

(NPV = net present value; ICC = initial capitol cost; BOS = balance of station = 26% ICC; O&M = operations and maintenance)


COE vs Number of Turbines
0.50
0.45
0.40
0.35
0.30
0.25
0.20
COE
0.476
0.469
0.461
0.453
0.447
0
1
2
3
4
Number of Turbines